Evaluating the Efficacy of Paleoliquefaction Analysis Techniques Using Modern Analogs

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Abstract: Using case studies from the 2010-2011 Canterbury, New Zealand earthquake sequence, this study assesses the accuracies of paleoliquefaction back-analysis methods and explores the challenges, techniques, and uncertainties associated with their application. While liquefaction-based back-analyses have been widely used to estimate the magnitudes of paleoearthquakes, their uncertain efficacies continue to significantly affect the computed seismic hazard in regions where they are relied upon. Accordingly, their performance is evaluated herein using liquefaction data from modern earthquakes with known magnitudes. It is shown that when the earthquake source location and mechanism are known, back-analysis methods are capable of accurately deriving seismic parameters from liquefaction evidence. However, because the source location and mechanism are often unknown in paleoseismic studies, and because accurate interpretation is shown to be more difficult in such cases, new analysis techniques are proposed herein. An objective parameter is proposed to geospatially assess the likelihood of any provisional source location, enabling an analyst to more accurately estimate the magnitude of a liquefaction-inducing paleoearthquake. This study demonstrates the application of back-analysis methods, provides insight into their potential accuracies, and provides a framework for performing paleoliquefaction analyses worldwide.